# COMMONWEALTH of VIRGINIA

**DEPARTMENT OF WASTE MANAGEMENT**
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SITE INVESTIGATION

OF

ALLIED CORPORATION - FRONT ROYAL
VA-034

Submitted By:

Commonwealth of Virginia

Department of Waste Management

September 9, 1988

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## 1.0 SUMMARY

The Department of Waste Management, Superfund Program, conducted a Site Investigation of Allied Corporation-Front Royal, VA-034, (hereinafter "Allied") on May 25, 1988. Soil, sediment, and surface water samples were collected on site. The purpose of the investigation was to evaluate the potential for and/or extent of environmental contamination at the site. Sampling efforts were designed to provide preliminary data on soil and water constituents on site and to determine possible future information needs.

There is significant inorganic contamination in various areas on-site. All soil/sediment samples have significant levels of arsenic, barium, chromium, copper, iron, magnesium, potassium and vanadium. Lead was detected at levels above the 10-day chemical health advisory limits in containment pond sample SW-5. The only EPA Target Analyte Metals not found at significant levels in any samples on-site are beryllium and thallium. (Cyanide analyses were not performed).

Significant organic contamination at the site includes carbon disulfide in the containment pond sediments, PAHs in various sediment samples, Aroclor 1254 in the containment pond sediments and downstream sediments and molecular sulfur in several samples. Also, gamma BHC (pesticide) was detected in the upstream sediment sample.

Please refer to the Inorganic and Organic Data Validation section for possible sources for these contaminants.

## 2.0 BACKGROUND INFORMATION

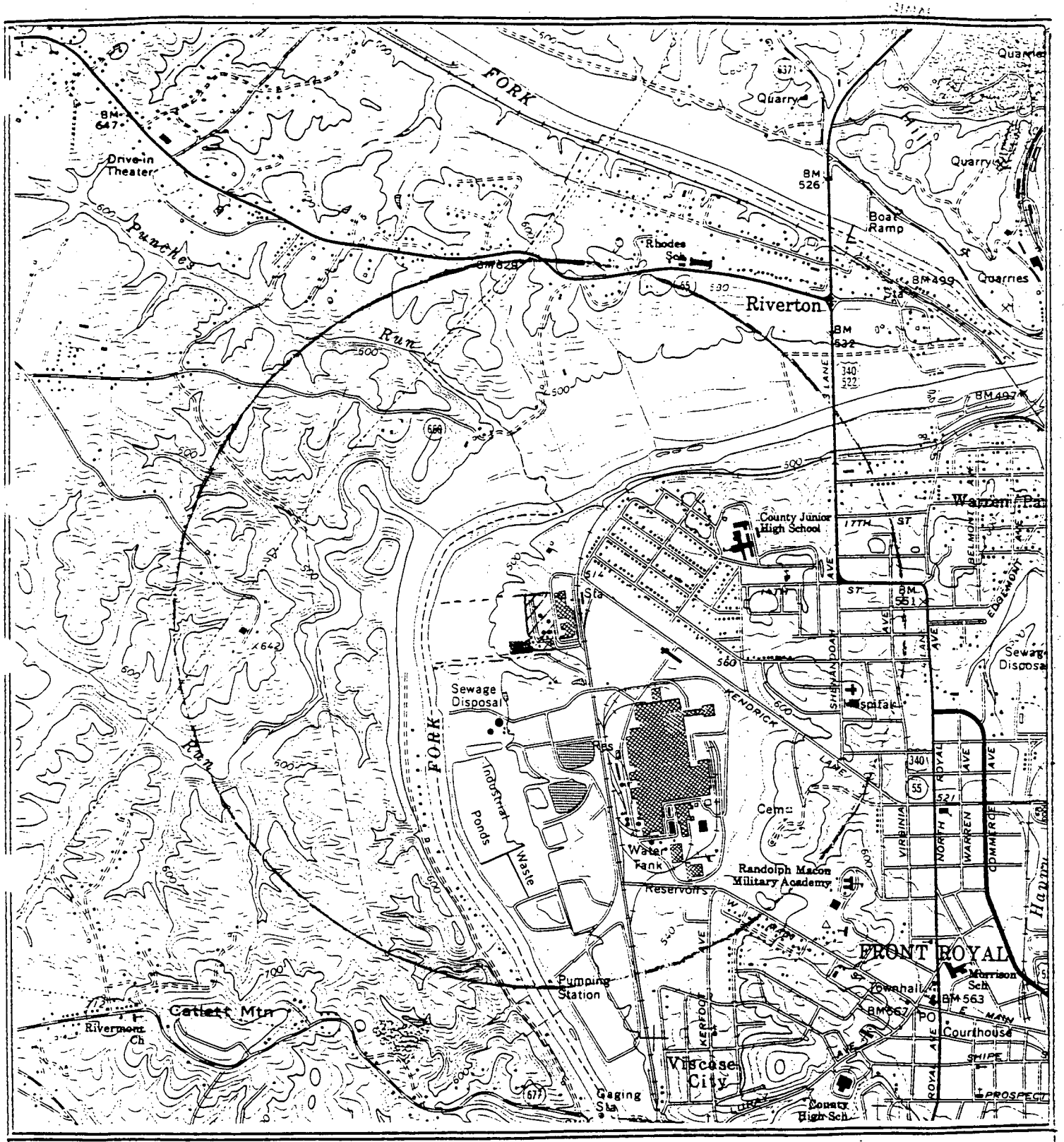
### 2.1 Site Location

The old Allied facility is located in the town of Front Royal, Warren County, Virginia at the end of Kendrick Lane. It is now the northeastern portion of the property owned by Avtex Fibers Inc. The site coordinates are 38° 55' 53" N., and 78° 12' 50" W. (Front Royal, Virginia 7.5' topographic quadrangle, 1967, Figure 1).

### 2.2 Site History

Prior to Allied's occupation of the site, the property was part of a small family-run farm. Circa 1944, Allied bought the property and began operations as a sulfuric acid manufacturer. A containment pond was installed in 1974 for use as a holding area where the temperature and pH (in the event of acid spills) of non-contact cooling water and surface run-off were adjusted. The water was then discharged in accordance with NPDES permit (No. 2399) dated July 28, 1974 to the intermittent stream along the southern boundary of the site (Kreglo, William, State Water Control Board (SWCB), telephone conversation, 9/1/88). Allied also had two on-site landfill areas where process wastes were disposed (Preliminary Assessment, 1984; Site Layout, Figure 2).

A Preliminary Assessment (PA) of the site was performed on February 24, 1984, by NUS FIT III personnel. At that time, Allied was still producing sulfuric acid from the process of burning sulfur. The assessment describes an

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Old processing area

Approximate boundary of former Allied property

Waste areas

Allied Corporation-Front Royal Works (now Avtex) Site Location Map
Front Royal, Virginia 7.5' topographic quadrangle, 1967

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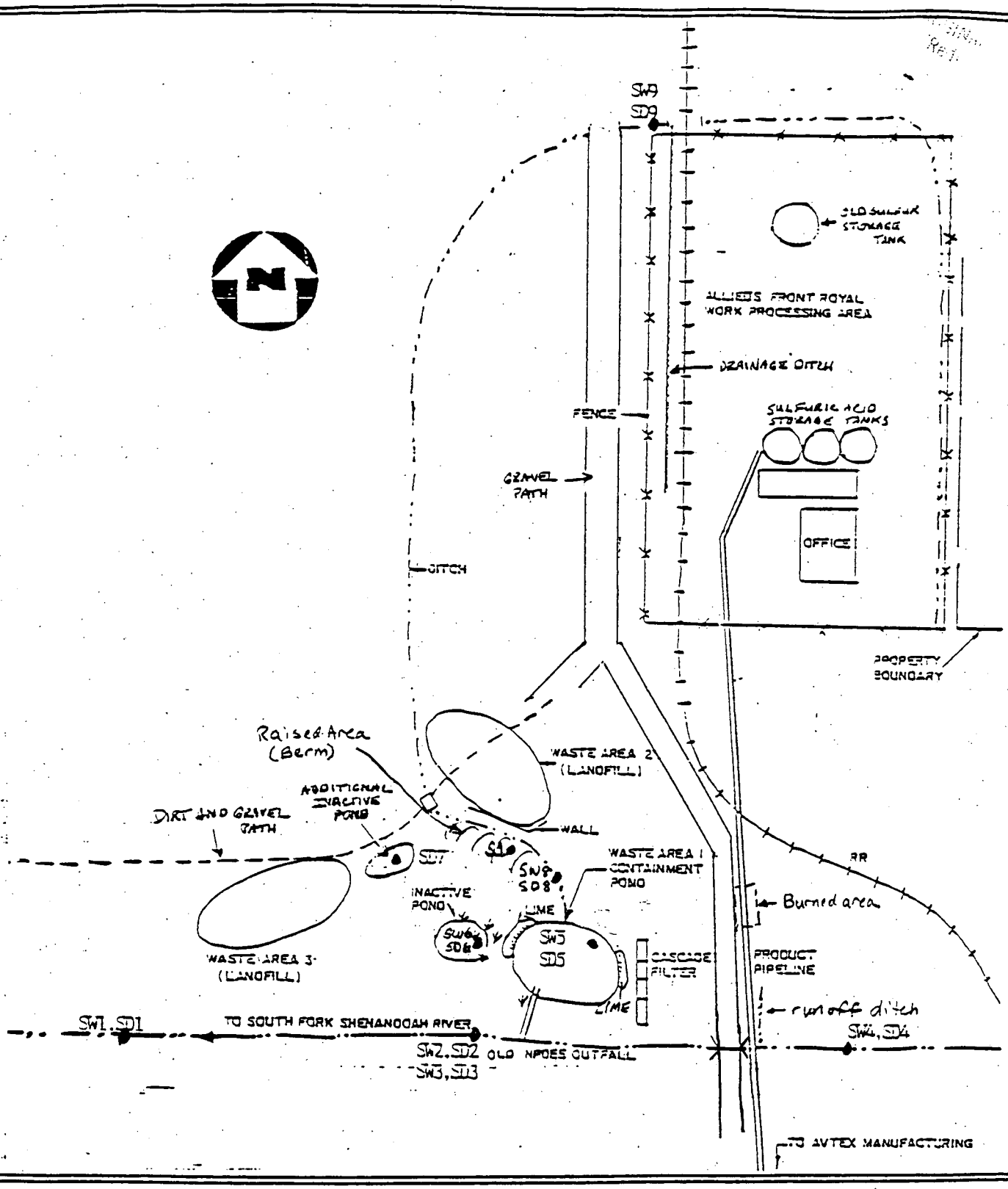
FIGURE NO: 1

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Sketch-No Scale

Allied's Front Royal Works, Front Royal, VA Site Sketch with Sampling Locations

VA-34

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FIGURE NO: 2

active holding pond, inactive pond adjacent to the holding pond, and two landfilled areas northwest of the holding pond (Preliminary Assessment, 1984; Site Layout, Figure 2).

In July or August 1986, the company operating at the site changed from Allied to General Chemical Corporation (Kreglo, SWCB, telephone conversation, 9/1/88). Avtex Fibers, Inc. (hereinafter "Avtex"), which operates the rayon manufacturing plant located south of the site, purchased the site in late 1986 (Avtex is the current owner and operator). Avtex uses the facility as a chemical transfer station for sulfuric acid. Avtex buys the acid from CIL in Sudsbury, Canada, and has it shipped by rail to the site where it is pumped into three above ground storage tanks (total capacity: 5,000 tons). Sulfuric acid is pumped through a steel pipeline from these tanks to the Avtex plant (approximately 0.5 miles away) where it is used in the rayon manufacturing process (Knepp, Willis H., Manager, Corporate Raw Materials Purchasing, Avtex Fibers Inc., personal communication, 5/2/88).

Shortly after the site was purchased by Avtex, a pipeline was installed from the holding pond to Avtex's wastewater treatment plant located on the South Fork of the Shenandoah River about 0.25 miles downstream of the Avtex plant. When the water from the containment pond (now only surface run-off) reaches a certain level, a switch activates a pump which pumps the water out to the treatment plant. There the water is adjusted for pH, BOD, and any zinc is removed (zinc sulfate is used in the process of making rayon). According to Mr. Joe Ringer, Avtex employee, the water has not been directly discharged to the creek in over one year although the NPDES permit is still valid (Ringer, personal communication, 5/2/88; Kreglo, telephone conversation, 9/1/88).

Three buildings from the old plant are still being used by Avtex. One contains office space and a laboratory which analyzes each shipment of sulfuric acid. If the water from the containment pond was ever discharged directly to the stream, it would first be tested in the laboratory and adjusted accordingly. Another building is used for showers and lockers, the third contains a compressor which is used to produce the air pressure which forces the sulfuric acid out of the railroad tank cars when unloading. This compessor (manufactured in 1944) was purchased by Avtex along with the site in 1986. The old storage tanks (two 2,000 ton and one 1,000 ton tank) and pipeline to the Avtex facility are intact and being used by Avtex. Most of the old processing equipment is still located on site, but is unused (Ringer, personal communication; Site Reconnaissance visit, 5/2/88).

A drainage system exists underneath the old processing area; all material is routed to the drainage ditch around the processing area, and ultimately to the containment pond. Lime and a tank of caustic soda are kept on-site to neutralize a spill or the pond in the event of a spill (site visit, 5/2/88). Avtex also has a NPDES permit (January, 1986) for a second outfall from the old Allied site. This outfall is directly onto the ground north of the site, and winds across the flood plains to the South Fork of the Shenandoah River. According to Mr. Kreglo, SWCB, Avtex has not used this second outfall (Kreglo, telephone conversation, 9/1/88).

A Site Reconnaissance was conducted on May 2, 1988 by Department of Waste Management (DWM) personnel. As mentioned above, the active holding pond now only receives surface run-off from the site, and an inactive pond is located adjacent to it (both referred to as waste area 1). The landfilled areas (waste areas 2 and 3) appeared to be unchanged from the description in the PA. However, another dry pond-like area was discovered just northwest of the inactive pond. This will be referred to as waste area No. 4 in this report (Site Layout, Figure 2).

During the Site Reconnaissance visit, DWM personnel noted a swampy smell near the intermittent stream, orange and green algae-like material in the stream and in the drainageways at the processing area, scrap metal lying around the site (which is slowly being removed, according to Mr. Knepp), cattails on both containment ponds, and sulfur and lime on the ground around the site. The drainage ditch was mostly dry at the time of the site visit, although the stream had some water flow. The old Avtex landfill is located across the intermittent stream from the old Allied site; according to Mr. Ringer, it contains tow (unused, unwashed rayon). Mr. Kreglo, SWCB, indicated that this old landfill was observed leaching into the intermittent stream for a number of years. This landfill now has a collection pond from which leachate is pumped to a treatment system (Kreglo, telephone conversation, 9/1/88). The storage tanks and the pipeline have no catch basins or any other sort of containment (Knepp, personal communication; site visit, 5/2/88).

On May 25, 1988, a Site Investigation was conducted by DWM personnel. Surface water, sediment, and soil samples were taken. Sections 5-8 of this report detail the results from the Site Investigation.

## 2.3 Waste Type Quantity and Handling

As mentioned above, the Allied facility was engaged in the process of burning sulfur to produce sulfuric acid. According to information received from Allied representatives at the time of the PA, the waste disposed of at the site was generated by the production process. Substances used in the production process include: sodium chloride, sodium carbonate, limestone, elemental sulfur, vanadium pentoxide, caustic soda, fuel oil and gasoline. In addition, small quantities of the corrosion products of lead, chromium and nickel may be present from the processing equipment. At the time of the PA, waste materials were shipped off site for recycling, or for disposal in approved landfills.

According to the PA, Allied periodically dredged the holding pond and piled the sediments nearby, forming a large earthen berm.

Waste area No. 2 was used for burial of spent vanadium pentoxide ($V_2O_5$) (the sulfuric acid catalyst), a mixture of diatomaceous earth, resin and binders containing 6 to 7 percent by weight $V_2O_5$, and trace quantities of other metallic ions such as sodium and potassium. Total quantity of the catalyst was approximately 126,800 pounds (of which approximately 2,500 pounds is vanadium). Also buried at waste area No. 2 was steel wool, used in acid mist elimination in Allied's air drying tower (Preliminary Assessment, 1984).

Materials buried at waste area No. 3 included: approximately 20 tons of insulation materials, probably containing asbestos (buried loose), ceramic packing material, and possibly small quantities of the $V_2O_5$ sulfuric acid catalyst (Preliminary Assessment, 1984).

According to a Preliminary Survey of the site (performed in 1980), other substances buried in the landfilled areas on-site include: salts, heavy and trace metals, drummed waste, pesticides (a one-time burial), and limed sediments from the containment ponds (information obtained in 1980 from Bob Ford of Allied, Appendix C).

The purpose for waste area No. 4 is unknown.

## 3.0 ENVIRONMENTAL SETTING

### 3.1 Population

The town of Front Royal is encompassed within a three mile radius of the site. The current estimated population for the town is 13,500. Using that number, and a multiplier of 3.8 people per house outside the town limits, the estimated population within a three mile radius of the site is 17,000. Within two miles, one mile and 0.25 miles of the site are an estimated 15,300, 4,800 and 258 people respectively.

### 3.2 Land Use

The property is bordered on the west by the South Fork of the Shenandoah River. An unnamed tributary runs along the site's southern boundary. Across this tributary is the Avtex plant which manufactures rayon staple, rayon yarn and polypropylene. The Avtex site (VA-113) is presently listed on the EPA National Priority List and is in the Remedial Investigation/Feasibility Study (RI/FS) stage. Directly east of the site are abandoned buildings once used by Old Virginia for the manufacturing of jam products. A residential neighborhood is located northeast of the site.

### 3.3 Climate and Topography

The site is at an elevation of 530 to 460 feet MSL at the South Fork of the Shenandoah River. The mean annual temperature as recorded by NOAA at the Winchester weather station (located in neighboring Frederick County) is 53.2°F (11.8°C). The average annual precipitation is 41.47 inches (105.3 cm).

### 3.4 Geology and Soils

Front Royal falls within the Valley and Ridge Physiographic Province. According to a Geologic Map of the Front Royal Quadrangle, the site is underlain by the Ordovician age Martinsburg Formation. This formation consists of alternating thin, olive-green to gray shale and greenish-gray lithic sandstone. The basal part is black, silty shale and scattered thin beds of black limestone (Calver, 1975). An Allied representative indicated that shale bedrock was found on-site at a depth of approximately 2 feet during excavation for the containment pond (Preliminary Assessment Report, 1984).

Overlying the bedrock are Quaternary low level terrace deposits composed of pebbles and cobbles of sandstone and quartzite in a sandy-clay matrix (Calver, 1975).

Soil along the South Fork of the Shenandoah River just west of the site is Chagrin fine sandy loam. It is deep, nearly level and well-drained. The surface layer (to about ten inches) is typically dark brown fine sandy loam. Dark, yellowish-brown fine sandy loam makes up the subsoil. The substratum (between 31-37 inches deep) is dark yellowish-brown fine sandy loam. Beneath this is a layer of dark grayish-brown loam (Holmes, 1984; Figure 3, No. 9).

About 0.125 miles east of the river, adjacent to the processing area and pond and landfilled areas, the soil is Dyke loam, a deep, strongly sloping, well-drained soil. Surface soils are typically dark reddish-brown loam (to about five inches). Subsoils are dark red clay and dark red cobbly silty clay loam (below 40 inches) (Holmes, 1984; Figure 3, No. 17C).

Underlying the site is an area described in the Soil Survey of Warren County as "pits, quarries, and dumps." It is assumed that the Dyke loam once was the underlying soil (Holmes, 1984; Figure 3, No. 34).

Permeability of both soil types is moderate, and organic matter content is low. The Dyke loams are commonly strongly acid unless limed. Flooding is common in the Chagrin soil (Holmes, 1984).

## 4.0 HYDROLOGY

### 4.1 Ground Water

Depth of wells in the central and western parts of Warren County average about 100 feet. Water level is usually between 40 and 60 feet below the surface. Carbonate formations are considered the most favorable producers of ground water in the area (Cady, 1936).

Ground water depth on-site is expected to be shallow due to the proximity of the stream. Flow within the shallow water table aquifer is expected to be westward, towards the South Fork of the Shenandoah River.

There is one abandoned well on the Front Royal site, which is located near disposal area No. 2. It is the old home well (depth unknown) from the farm house originally located there (Ringer, personal communication, 5/2/88). According to an earlier EPA/SWCB inspection, the well is silted-in, has reportedly been contaminated with human waste, and is not currently used. This well was not observed during the Site Reconnaisance.

Other ground water wells in the area are located on the west side of the South Fork of the Shenandoah. Avtex commissioned a detailed ground water study by Geraghty and Miller, consultants, as part of the RI/FS study. Contaminated domestic wells were found to be confined to a narrow zone along the west bank of the South Fork of the Shenandoah River, and the contamination was attributed to Avtex's waste disposal basins located on the east side of the river, about 0.25 miles south of the Allied site (PA/SI of Avtex Fibers, 1985).

## 4.2 Surface Water

Surface run-off from the old processing area is collected in a ditch and diverted to the containment pond. From there, the neutralized wastewater was discharged into an unnamed tributary of the South Fork of the Shenandoah River (it is now pumped out to the Avtex water treatment facility). The old NPDES discharge point on the tributary is about 1,500 feet upstream of the river (site visit, 5/2/88).

Surface run-off from the remainder of the site, including the landfilled areas, is only partially trapped by the collection ditch which flows into the containment pond. Waste areas No. 3 and 4, and the dredge berm are topographically below the ditch; therefore, run-off from these areas would enter the stream (site visit, 5/2/88).

According to the November 13, 1985 Preliminary Assessment/Site Inspection for Avtex Fibers, leachate has been observed flowing into the unnamed tributary, and the Virginia State Water Control Board (SWCB) had requested that corrective measures be taken.

Flood potential on site is high, as the western half of the site is within the 100 year flood prone area. However, the processing and waste disposal areas do not fall within the mapped flood prone zone.

The South Fork of the Shenandoah River, located about 0.25 miles west of the site, is used for recreational and industrial purposes. The cooling water used at the Allied facility was obtained from the river, and the cooling water for Avtex's processes are now obtained from the river (Knepp, personal communication, 5/2/88).

## 4.3 Water Supply

The Town of Front Royal supplies the town and some surrounding areas with water from an (b) (9) [redacted] The (b) (9) [redacted] It provides ninety percent of the town's supply. The (b) (9) [redacted] along Route 522 and in Harmony Hollow across [redacted] from the U.S Department of Agriculture Research Center and comprise the other ten percent of the supply.

The town supply serves the town of Front Royal, north of the town along Route 522 for approximately four miles, east of town to the Happy Creek area, south about 4.5 miles to Harmony Hollow, and about 1.5 miles northwest of the town between the South and North Fork of the Shenandoah River to the end of Duck Street where a new subdivision of one hundred and nine homes is located (Tewalt, Engineer, Town of Front Royal, telephone conversation, 6/16/88; Front Royal and Chester Gap, Virginia, 7.5' topographic quadrangle, 1967).

ORIGINAL (Red)

# 5.0 FIELD WORK

## 5.1 Selection of Sampling Locations

Seven (7) surface water samples and nine (9) soil samples were collected at the Allied Front Royal site, not including duplicates and field blanks. Prior to the sampling date there was some concern that there would not be enough water in the drainage ditch to collect surface water samples, but there was rainfall for a few days before the sampling event, and all samples were taken as planned.

Samples SW-1 and SD-1 through SW-9 and SD-9 were surface water and associated sediment samples (with the exception of SD-7 which did not have an associated water sample taken because the pond was dry). These were collected from three sources: an intermittent stream that flows on the site's southern boundary, a drainage ditch that runs through the property, and two waste ponds on the site (Site Layout, Figure 2).

SW-4 and SD-4 are background samples for the site, and were collected from the intermittent stream upstream of the site. These samples were used for comparative purposes.

One soil sample (S-1) was taken from an earthen berm north of the waste ponds, where it is alleged that dredge material had been piled in the past. The sample was taken at a depth of 4-8 inches after augering.

For sample descriptions and times, please refer to Appendix F.

## 5.2 Sample Descriptions

**WATER:**

SW-1 Downstream water sample. Slightly muddy, organics. Flow rate: 1 foot/second (ft./sec). Channel depth: 8 - 12 inches. Channel width: 3 feet. Average conductivity: 581 umhos. pH=6.7.

SW-2 Midstream water sample. Small inlet area, much vegetation. Slightly murky, organics. Water depth: 3 inches. Flow rate: 0.5 ft./sec. Channel depth: 12 inches. Channel width: 1 foot. Average conductivity: 467 umhos. pH=6.4.

SW-3 Duplicate at midstream. Average conductivity: 564 umhos. pH=6.5.

SW-4 Upstream water sample. Opaque, little organic matter. Flow rate: 0.2 ft./sec. Channel depth: 12 inches. Channel width: 1.5 - 2.0 feet. Average conductivity: 500 umhos. pH=6.3.

SW-5 Active containment pond water. Average conductivity: 1212 umhos. pH=4.4.

SW-6 Inactive containment pond water. Average conductivity: 1020 umhos. pH=6.7.

SW-8 Drainage ditch water; just north of active containment pond. Clear. Flow rate: 1 ft./sec. Channel depth: 6 inches. Channel width: 8 - 12 inches. Average conductivity: 1481 umhos. pH=2.7.

SW-9 Drainage ditch north of old processing area. Channel depth: 3.5 inches. Channel width: 8 - 12 inches. Average conductivity: 1356 umhos. pH=6.4.

FB-1 Field blank. Cap for pesticide jar fell onto the ground. Average conductivity: 1.4 umhos. pH=4.7.

**SOIL SEDIMENT:**

S-1 Berm area. Sample augered. Taken at 4 - 8 inches. Concrete encountered at one foot. Thick, clayey soil.

SD-1 Downstream sediment. Bottom of stream bed contains cobbles. Sample taken along bank at and below water level. Gravelly, silty sand, some organics and roots. Black silty sand at 2 inches.

SD-2/SD-3 Midstream sediment and duplicate. Much vegetation. Sample is brown sandy silt. Much organic matter and clay pockets.

SD-4 Upstream sediment. Brown, gravelly sand. Twigs and decomposing organic matter (in BNA sample).

SD-5 Active containment pond sediment. Jell-like, beaded-up like mercury. Thin layer of silt, black silt underneath. Some organic material (leaves).

SD-6 Inactive containment pond sediment. Thin layer of silt at surface. Coarse-grained underneath. White, orange, brown, gray. Some organic matter.

SD-7 Dry pond sediment. Taken at 0 - 1 inches in center of pond. Red, clayey silt.

SD-8 Drainage ditch sediment north of active containment pond. Channel bed: mostly silty sand. Sample: brown, silty sand. Organic matter, gravel and clay pockets.

SD-9 Drainage ditch sediment north of old processing area. Brown and gray silty clay with sand. Sticky. Crystallized sulfur present.

## 5.3 Observations

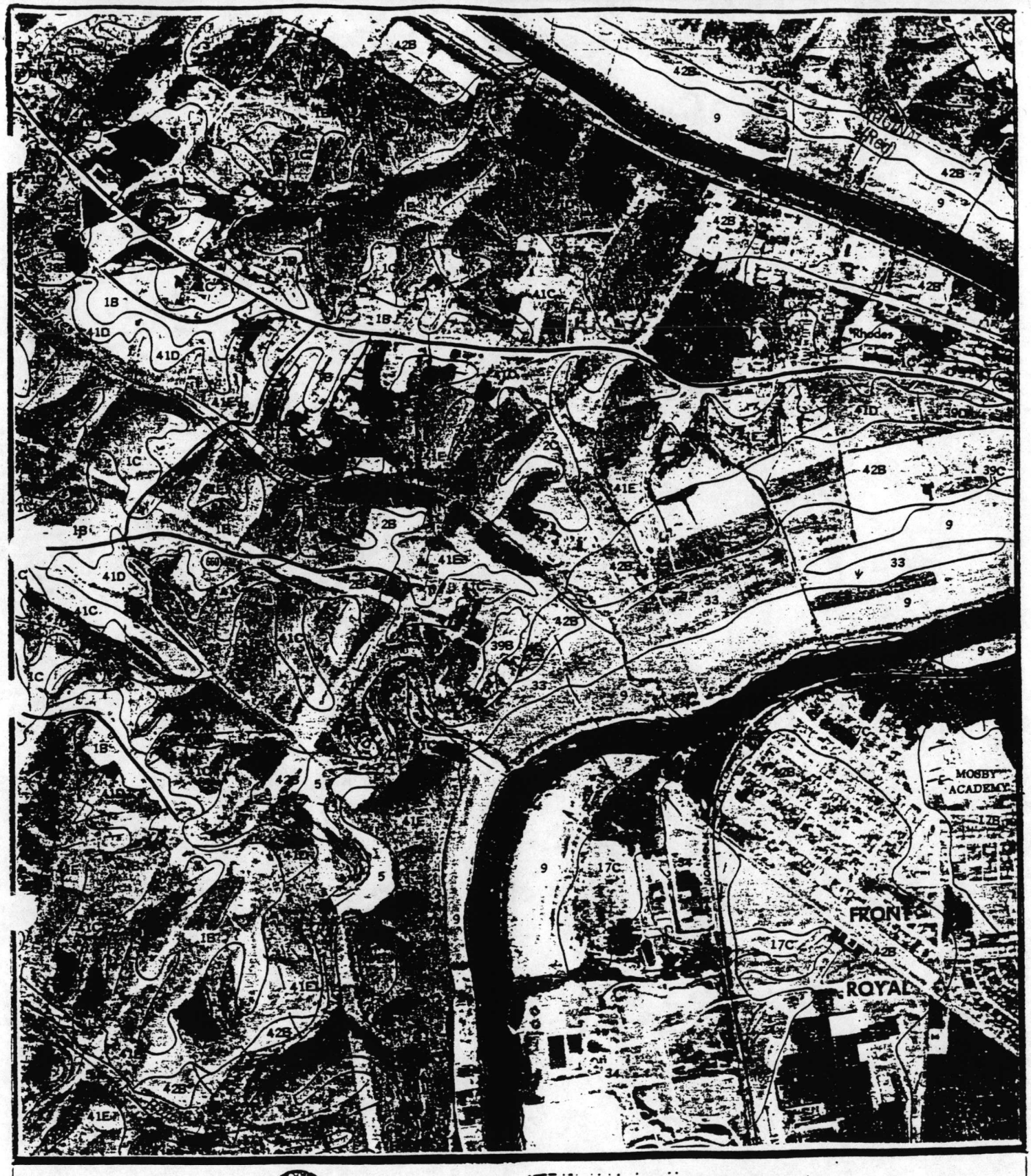
Field personnel found an area of dead grass approximately 9' x 15' underneath a section of the sulfuric acid pipeline (Figure 2, Site Layout).

The sediment collected from the active containment pond (SD-5) was jell-like and beaded up.

Cattails, tadpoles and waterbugs were observed in the inactive waste pond.

A foamy green discharge was seen flowing into the tributary downstream from the background (upstream) sample (SW-4, SD-4). (See photos, Appendix A).

Dead worms were observed in the water at sample location SW-8 and SD-8.




COMMONWEALTH of VIRGINIA

Soil Map of the Allied Front Royal Site and surrounding area
Soil Survey of Warren County Virginia, 1984

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FIGURE NO: 3

# 6.0 DATA VALIDATION

## 6.1 Inorganic Data Validation

**MEMORANDUM**

**TO:** Project File

**FROM:** Emma J. Pope

**DATE:** August 22, 1988

**THROUGH:** Paul Kohler

**SUBJECT:** Inorganic Data Review
Allied Corporation-Front Royal Works VA-034

INTRODUCTION

The findings offered in this report are based upon a general review of sample data including: holding times, initial calibration verification (ICV) and continuing calibration verification (CCV), blanks, ICP interference check sample, laboratory control samples (LCS), duplicates, matrix spikes, and furnace and ICP quality control. Eight aqueous samples, nine sediment samples and one soil sample were collected by Department of Waste Management personnel on May 25, 1988 and shipped to Cambridge Analytical Associates, Boston, Massachusetts for analysis.

Data is summarized in Tables 1 and 2. The complete list of elements analyzed for, the results, and associated detection limits are located in Appendix F of the Site Investigation Report.

The data summary contains the following qualifier codes:

**J** - Analyte present. Reported value may not be accurate or precise.

**K** - Analyte present. Reported value may be biased high. Actual value is expected to be lower.

**L** - Analyte present. Reported value may be biased low. Actual value is expected to be higher.

**B -** Analyte present. Reported value may be due to blank contamination. Reported value is less than five times the level in the highest blank.

**UL-** Analyte undetected. Reported value may be biased low.

**UJ-** Analyte undetected. Reported value may be inaccurate or imprecise.

SUMMARY

This Quality Assurance Review has identified several areas of concern. Preparation blank and continuing calibration blank contamination of chromium, iron, selenium, and vanadium resulted in qualification of concentrations less than five times the highest blank contamination in the soil matrix. In the aqueous matrix, preparation blank and continuing calibration blank contamination of chromium and vanadium resulted in qualification of concentrations less than five times the highest blank contamination.

Low matrix spike recoveries for antimony, cadmium, chromium, manganese, silver and zinc in the soil matrix, and for antimony and silver in the aqueous matrix; and a high spike recovery for mercury in the soil matrix, necessitated qualification of the associated data in both matrices.

In the soil matrix, post digestion spike recoveries for samples SD-7 and SD-1 in the arsenic analyses, samples SD-2 in the lead analysis, and samples SD-7, SD-5, and SD-2 in the selenium analyses were out of control limits. The concentrations for these samples for the various parameters have been qualified as biased high or low depending upon the percent recovery.

In the aqueous matrix, post digestion spike recoveries for samples SW-5, SW-6, and SW-8 in the lead analyses were out of control limits and necessitated qualification of the lead concentrations for the samples.

Duplicate analyses for antimony and selenium in the soil matrix, and for lead in the aqueous matrix were out of the relative percent difference (RPD) control limits. The corresponding concentrations have been qualified.

ICP serial dilution analyses were out of the percent difference control limits for sodium and zinc in the soil matrix and for manganese in the aqueous matrix, indicating a possible physical or chemical interference due to sample matrix.

QUALIFIERS AND COMMENTS

It is recommended that this data package be utilized only with the following qualifier statements:

with the following qualifier statements:

* Preparation blank contamination for vanadium in the soil matrix (5.8 ug/l) and in the aqueous matrix (27 ug/l), resulted in qualification of associated samples with concentrations less than five times the blank contamination.

* Continuing calibration blank contamination for chromium (9.17 ug/l), iron (47.7 ug/l), selenium (2.20 ug/l), and vanadium (28.2 ug/l) in the soil matrix resulted in qualification of associated samples with concentrations less than five times the blank contamination.

* Continuing calibration blank contamination for chromium (9.17 ug/l) and vanadium (28.2 ug/l) in the aqueous matrix resulted in qualification of associated samples with concentrations less than five times the blank contamination.

* Soil matrix spike recoveries for antimony (44%), cadmium (57%), chromium (69%), manganese (51%), mercury (280%), silver (73%), and zinc (74%) were out of control limits. Reported concentrations of all these analytes in the soil matrix except mercury may be biased low and have been flagged L. Mercury concentrations may be biased high and have been flagged with a K. (In some cases the L or K qualifier is not found next to the sample data. This is because the data has been estimated and flagged J. However, the low and high qualifications still apply).

* Aqueous matrix spike recoveries for antimony (73%) and silver (71%) were out of control limits. Reported concentrations of these analytes in the aqueous matrix may be biased low and have been flagged L or UL.

* Post digestion spike recoveries for arsenic data in the soil matrix were out of control limits in samples SD-7 (78%) and SD-1 (76%). These samples may be biased low and have been qualified L. The samples were subsequently quantitated using the method of standard addition (MSA). In both cases, the correlation coefficient was less than 0.995 and so arsenic concentrations in SD-7 and SD-1 have been qualified J. (The L qualifier has been left off).

* Post digestion spike recoveries for lead data in the soil matrix were out of control limits in sample SD-2 (39%). The results for this sample are qualified as biased low (L).

* Post digestion spike recoveries for selenium data

in the soil matrix were out of control limits in samples SD-7 (148%), SD-5 (65%), and SD-2 (69%). Sample SD-7 has been qualified as biased high (K). Samples SD-5 and SD-2 have been qualified as biased low (L). In all three cases, the samples were subsequently quantitated using MSA. All correlation coefficients were under 0.995, therefore these samples for the selenium parameter have been flagged J. (The low and high qualifiers have been left off).

* Post digestion spike recoveries for lead data in the aqueous matrix were out of control limits for samples SW-5 (65%), SW-6 (69%), and SW-8 (75%). These samples are biased low for this parameter. All were quantitated using MSA; the correlation coefficient for SW-8 was under 0.995, therefore this sample is also estimated.

* Soil duplicate analyses for antimony (63.2 RPD), and selenium (43 RPD) exceeded the relative percent difference control limit of +/- 35%. Reported concentrations of antimony and selenium are estimated and have been flagged J or UJ.

* Aqueous duplicate analyses for lead (99 RPD) was out of RPD control limits. Reported concentrations of lead in all aqueous samples have been flagged J.

* ICP serial dilution analyses were out of the percent difference control limit (+/- 10%) for manganese (10.8%) in the aqueous matrix, and for sodium (88%) and zinc (18%) in the soil matrix. Reported concentrations of these analytes have been qualified J as a result of possible chemical or physical interference.

DISCUSSION OF RESULTS

Levels of analytes which are considered significant for inorganic data review are those which are at least five times the level of the respective background sample (SW-4 for surface water and SD-4 for soil/sediment). Much of the data is estimated, therefore, the qualifiers must be used when reviewing the results.

All soil/sediment samples had levels of arsenic (3.0-43 mg/kg), barium (125-452 mg/kg), chromium (4.2-479 mg/kg), copper (5.9-311 mg/kg), iron (20,600-135,000 mg/kg), magnesium (431-7,120 mg/kg), potassium (103-1,250 mg/kg), and vanadium (46-297 mg/kg) at five times above the background level. The following paragraphs describe additional metals found at significant levels in specific samples.

In sediment sample SD-8 (drainage ditch, south of waste area #2) lead (27 mg/kg), and mercury (1.4 mg/kg), were detected at

levels greater than five times the reported level in SD-4. The vanadium concentration is qualified due to preparation and continuing calibration blank contamination, however, since it shows up in all samples but the background, it still should be considered significant.

Samples SD-2 and SD-3 (duplicates at midstream) showed significant levels of the following additional contaminants: aluminum (27,100 mg/kg; only SD-2), cadmium (13 and 5.9 mg/kg), calcium (10,100 and 9,640 mg/kg), cobalt (68 and 44 mg/kg), lead (346 and 269 mg/kg), manganese (3,410 and 1,340 mg/kg), mercury (0.45 and 0.67 mg/kg), nickel (138 and 82 mg/kg), selenium (6.0 and 3.9 mg/kg), and zinc (1,990 and 1,160 mg/kg).

In sediment sample SD-7 (dry pond) antimony (303 mg/kg), cadmium (16 mg/kg), calcium (150,000 mg/kg), manganese (578 mg/kg), mercury (1.2 mg/kg), nickel (291 mg/kg), selenium (16 mg/kg), silver (7.8 mg/kg), and zinc (372 mg/kg) were detected at significant levels.

Sample SD-5 (active containment pond) had levels of calcium (142,000 mg/kg), lead (455 mg/kg), mercury (2.0 mg/kg), nickel (70 mg/kg), selenium (48 mg/kg), silver (11 mg/kg), sodium (1,290 mg/kg), and zinc (502 mg/kg) at five times higher than background levels.

Levels of cadmium (3.5 mg/kg), calcium (2,090 mg/kg), and lead (36 mg/kg) were all at significant levels in soil sample S-1 (berm area).

Sample SD-1 (downstream) showed significant levels of cadmium (2.9 mg/kg), calcium (6,980 mg/kg), lead (357 mg/kg), manganese (1,180 mg/kg), mercury (0.42 mg/kg), nickel (17 mg/kg), selenium (1.5 mg/kg), and zinc (345 mg/kg).

Sediment sample SD-6 (inactive containment pond) showed concentrations five times above background in calcium (178,000 mg/kg), lead (107 mg/kg), and selenium (1.9 mg/kg).

Because concentrations of cadmium and silver in the soil matrix are biased low, it is possible that they could be present in the samples where they are reported as undetected.

The only analyte detected at five times above background in surface water sample SW-1 (downstream) was cobalt (81 ug/l).

Cobalt was also detected in SW-2 (midstream) at five times above background (73 ug/l). No significant levels of analytes were detected in SW-3, the duplicate of SW-2.

In sample SW-5 (active containment pond) cobalt (64 ug/l), and lead (30 ug/l) were detected at significant levels. The lead concentration (which is 10 ug/l above the 10 day health advisory for drinking water) is estimated due to post digestion spike

recoveries being out of control limits.

The only analyte in significant amounts detected in SW-6 was silver (10 ug/l). Since this concentration was qualified as biased low, the actual amount could be higher.

Levels five times above background of aluminum (19,300 ug/l), chromium (18 ug/l), copper (92 ug/l), iron (8,370 ug/l), lead (18 ug/l), and manganese (1,500 ug/l) were detected in surface water sample SW-8 (drainage ditch south of waste area #2). Sample SW-8 is the only water sample which had any levels of chromium.

Sample SW-9 (north drainage ditch) showed a significant level of cobalt (70 ug/l).

All surface water samples have "biased low" qualifiers on the antimony and silver parameters, so the possibility exists that these metals may be in the sample but did not show up in analysis.

Vanadium was also detected in surface water samples SW-1, SW-2, SW-3, SW-4, SW-5 and SW-9 (not above five times background). Some of the results could have been affected by blank contamination.

As mentioned in the waste type section of the site investigation report (section 2.3), sodium (in the form of sodium chloride and sodium carbonate) and vanadium pentoxide were waste products associated with the sulfur production process. Small quantities of lead, chromium, and nickel could be present from the processing equipment. All samples could be affected by run-off from the processing area, including sample S-1, the berm area where dredged sediments from the holding ponds had been piled.

Waste area No. 2 was used for disposal of vanadium pentoxide, sodium and potassium. Samples SW-8, SD-8 and samples farther downgradient could be affected by waste area No. 2.

Waste area No. 3 may have been used for disposal of small quantities of vanadium pentoxide in addition to ceramic materials and asbestos. Downstream sediment sample SD-1 and surface water sample SW-1 could be affected by this waste area. Downstream sediment sample SD-1 contained a significant level of vanadium, and SW-1 had trace quantities.

EJP

Project: Allied Corporation - Front Royal, Virginia
May 25, 1988

| Sample #: | SD-8 | SD-9 | SD-3 | SD-7 | SD-4 | SD-5 | S-1 | SD-1 | SD-6 | SD-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| % Solids | 67.6 | 67.6 | 31.7 | 51.9 | 41.7 | 22.5 | 78.6 | 44.9 | 31.3 | 24.2 |
| units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Aluminum | 8,180 | 18,300 | 15,900 | 10,600 | 4,000 | 7,780 | 12,700 | 10,100 | 6,360 | 27,100 |
| Antimony | 51 J | 91 L | 114 J | 303 J | 41 J | 128 J | 88 J | UJ | UJ | 118 J |
| Arsenic | 3.0 | 3.6 | 20 | 43 J | | 13.4 | 5.4 | 31 J | 7.6 | 23 |
| Barium | 452 | 137 | 140 | 410 | | 188 | 167 | 153 | 125 | 164 |
| Beryllium | | | | | | | | | | |
| Cadmium | UL | UL | 5.9 L | 16 L | UL | UL | 3.5 L | 2.9 L | UL | 13 L |
| Calcium | 307 | 1,330 | 9,640 | 150,000 | 374 | 142,000 | 2,090 | 6,980 | 178,000 | 10,100 |
| Chromium | 22 L | 4.2 L | 93 L | 479 L | UL | 130 L | 10 L | 34 L | 55 L | 132 L |
| Cobalt | | | 44 | | | | | | | 68 |
| Copper | 15 | 5.9 | 153 | 311 | | 234 | 14 | 58 | 44 | 254 |
| Iron | 22,300 | 23,600 | 40,400 | 135,000 | 2,130 | 61,000 | 36,600 | 23,900 | 20,600 | 59,000 |
| Lead | 27 | 13 | 269 | 476 | 5.1 | 455 | 36 | 357 | 107 | 346 L |
| Magnesium | 431 | 706 | 1,440 | 4,020 | | 2,370 | 578 | 974 | 7,120 | 2,300 |
| Manganese | 123 L | 24 L | 1,340 L | 578 L | 86 L | 248 L | 291 L | 1,180 L | 259 L | 3,410 L |
| Mercury | 1.4 K | | 0.67 K | 1.2 K | | 2.0 K | | 0.42 K | | 0.45 K |
| Nickel | | | 82 | 291 | | 70 | | 17 | | 138 |
| Potassium | 908 | 909 | 241 | 373 | | 134 | 1,250 | 610 | 103 | 862 |
| Selenium | UJ | UJ | 3.9 J | 16 J | UJ | 48 J | UJ | 1.5 J | 1.9 J | 6.0 J |
| Silver | UL | UL | UL | 7.8 L | UL | 11 L | UL | UL | UL | UL |
| Sodium | 124 J | 78 J | 353 J | 944 J | 209 J | 1,290 J | 40 J | 245 J | 778 J | 494 J |
| Thallium | | | | | | | | | | |
| Vanadium | 99 B | 46 B | 79 B | 145 | | 297 | 63 | 55 | 60 | 143 |
| Zinc | 24 J | 24 J | 1,160 J | 372 J | 47 J | 502 J | 69 J | 345 J | 215 J | 1,990 J |
| Cyanide | | | | | | | | | | |

COMMONWEALTH of VIRGINIA

TABLE 1 INORGANIC DATA SUMMARY
SOIL/SEDIMENT SAMPLES

| DRAWN BY: | REVIEWED: | DATE: 9/8/88 |
|---|---|---|

Project: Allied Corporation - Front Royal, Virginia
May 25, 1988

| Sample #: | SW-1 | SW-2 | SW-3 | SW-4 | SW-5 | SW-6 | SW-8 | SW-9 | FB-1 |
|---|---|---|---|---|---|---|---|---|---|
| units | ug/l | ug/l | ug/l | ug/l | ug/l | ug/l | ug/l | ug/l | ug/l |
| Aluminum | 3,570 | 3,770 | 3,700 | 3,710 | 8,230 | 480 | 19,300 | 877 | |
| Antimony | UL | UL | UL | UL | UL | UL | UL | UL | UL |
| Arsenic | | | | | | | | | |
| Barium | | | | | | | | | |
| Beryllium | | | | | | | | | |
| Cadmium | | | | | | | | | |
| Calcium | 51,000 | 50,800 | 53,100 | 53,800 | 163,000 | 113,000 | 130,000 | 241,000 | 127 |
| Chromium | | | | | | | 18 B | | |
| Cobalt | 81 | 73 | | | 64 | | | 70 | |
| Copper | 20 | 19 | 18 | 17 | 68 | 16 | 92 | 20 | |
| Iron | 2,540 | 2,440 | 2,520 | 1,560 | 5,870 | 912 | 8,370 | 3,340 | |
| Lead | 4.1 J | 3.0 J | 3.1 J | 3.0 J | 30 J | 7.8 J | 18 J | | |
| Magnesium | 8,430 | 8,510 | 8,550 | 8,150 | 25,800 | 14,400 | 30,300 | 26,600 | |
| Manganese | 394 J | 408 J | 381 J | 296 J | 1,030 J | 588 J | 1,500 J | 129 J | |
| Mercury | | | | | | | | | |
| Nickel | | | | | | | | | |
| Potassium | 1,970 | 1,780 | 1,800 | 1,700 | 4,280 | 6,150 | 5,770 | 3,510 | |
| Selenium | | | | | | | | | |
| Silver | UL | UL | UL | UL | UL | 10 L | UL | UL | UL |
| Sodium | 32,300 | 31,800 | 32,100 | 20,400 | 59,400 | 55,800 | 57,600 | 29,700 | 202 |
| Thallium | | | | | | | | | |
| Vanadium | 21 B | 33 | 20 B | 30 | 25 B | | | 40 B | |
| Zinc | 126 | 137 | 117 | 166 | 568 | 61 | 286 | 26 | |

ORIGINAL (Red)

COMMONWEALTH of VIRGINIA

TABLE 2 INORGANIC DATA SUMMARY
AQUEOUS SAMPLES

| DRAWN BY: | REVIEWED: | DATE: 9/8/88 |
|---|---|---|

## 6.2 Organic Data Validation

**MEMORANDUM**

**TO:** Emma Pope, Environmental Scientist

**FROM:** Donald Spell, Environmental Scientist

**DATE:** September 7, 1988

**SUBJECT:** Allied Corporation, VA-034, Organic Data Validation

### Introduction

Ten (10) solid samples, eight (8) aqueous samples and one (1) field blank were analyzed for organic, Target Compound List (TCL) compounds by Cambridge Analytical Associates, using full Environmental Protection Agency (EPA) Contract Lab Program protocol.

Data from the analysis of the above samples have been reviewed to determine usability of results according to the National Functional Guidelines. There are some problems with this data. Principal areas of concern include violation of holding time for Base Neutral Acid (BNA) extractions in water samples, blank contamination and low recoveries for some surrogate spikes.

### Qualifiers

- Results for common lab contaminants methylene chloride, acetone and 2-butanone have been flagged (B) because the instrument levels of these compounds are not significantly higher than the levels found in any associated blank. The affected samples include the following:

VOA Samples

1. SW-1
2. SD-1
3. SD-2
4. SD-4
5. SD-5
6. SD-6
7. SD-7
8. SD-8
9. SD-9

- The holding time for BNA extractions were exceeded by two (2) days for all aqueous samples associated with this sample data group. These criteria were exceeded because the lab did not have personnel available to perform the extractions within contract holding times.

- Surrogate spike recoveries were high for solid samples SD-8 and SD-4 for toluene-d8.

- No soil surrogate recoveries for BNA samples SD-2, SD-5, SD-7 and SD-8 were provided because the surrogates were diluted out according to the lab.

- Surrogate spike recovery was low in BNA sample SW-4 for p-terphenyl-d14.

- Surrogate spike recoveries were below 10% in BNA samples SW-5 and SW-8 for 2-fluorophenol, 2,4,6-tribromophenol and p-terphenyl-d14.

- MS/MSD recoveries for samples SD-4 and SW-4 were below QC limits for the following matrix spiking compounds:

| SD-4 (VOA) | SW-4 (BNA) |
|---|---|
| trichloroethene | 1,4-dichlorobenzene<br>2,4-dinitrotoluene |

No action was taken to qualify the entire case based on the MS/MSD results.

- The absolute value of the percent difference (%D) between the initial response factor and the continuing calibration response factor was greater than 25% for one or two VOA compounds over a four (4) day period. The maximum %D was 39.1%.

- The absolute value of the percent difference (%D) between the initial response factor and the continuing calibration response factor was greater than 25% for two or three BNA compounds over a twelve (12) day period. The maximum %D was 45.5%.

- Internal standard areas were outside limits for the following compounds:

| Sample | Internal Standard |
|---|---|
| SD-4 (VOA) | BCM, DFB, CB2 |
| SD-8 (VOA) | CB2 |
| SD-2 (BNA) | CRY, PRY |
| SW-8 (BNA) | PRY |
| SD-2 (BNA) | CRY, PRY |

VOA samples were outside lower limits. BNA samples were outside upper limits.

- MSD % recoveries for four spike compounds in SW-4 were 5-7% above QC limits.

- The percent recoveries and relative percent differences for the following compounds in SD-4 MSD were above QC limits.

| | %Rec above limit | %RPD above limit |
|---|---|---|
| Heptachlor | 69 | 11 |
| gamma-BHC | | 53 |
| Aldrin | 326 | 6 |

Positive results for gamma-BHC in sample SD-4 have been flagged (J).

Discussion of Results

Only one none blank contaminant VOA compound was detected in the samples; SD-5 contained 6 ppb carbon disulfide. Sample SD-5 was collected from a containment pond near Avtex Fibers, Inc., the current owner of the property. Avtex manufactures rayon and carbon disulfide is used in rayon processing. Thus Avtex is the likely source of the $CS_2$.

Numerous PAHs were detected in the following samples: S-1, SD-1, SD-2, SD-3, SD-4, SD-5, SD-6, SD-7 and SD-9. Among the known carcinogenic PAHs the following were detected: benzo(a)anthracene in six (6) samples at concentrations ranging from .15 to 2.4 mg/kg; benzo(b)fluoranthene in nine (9) samples at concentrations ranging from .54 to 4 mg/kg; benzo(a)pyrene in seven (7) samples at concentrations ranging from .22 to 4 mg/kg; indeno(1,2,3-cd)pyrene in five (5) samples at concentrations ranging from .1 to .98 mg/kg. A possible source of PAHs found in the samples on-site is fuel oil, which was used in great quantities to operate machinery.

Aroclor 1254 was detected in two samples, SD-1 and SD-5 at 3100 and 4300 ppb, respectively. A potential source of the PCB is a compressor located on-site. The site has been active since 1944 which suggests a high likelihood that PCB oils may have been used.

Gamma-BHC was detected in sample SD-4. Site related records indicate a one time burial (Circa 1973) of pesticides on the property in the vicinity of waste areas 2 and 3. The types of pesticides landfilled were not disclosed in the records. Perhaps the presence of gamma-BHC in SD-4 is related to the pesticide burial.

No data base entries were retrieved for the overwhelming majority of TICs detected in the samples. A review of the TICs mass spectra revealed the probable presence of aliphatic and cyclic hydrocarbons. Molecular sulfur was also detected in several samples. Sulfur was utilized on-site to produce sulfuric acid which is transported via a pipe line from the site to Avtex Fibers, Inc.

Project: Allied Chem. Co., Front Royal, VA
Organic VOA

| Sample # | SW-1 | TRB | SD-1 | SD-6 | SD-2 | SD-4 | S-1 | SD-5 | SD-7 | SD-8 | SD-BRE | SD-9 | VBLK | VBLK | VBLK | VBLK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Description | | Trip Blank | | | | | | | | | | | VBLK 10601 | VBLK 10602 | VBLK 10603 | VBLK 10604 |
| Units | ug/L | ug/L | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/L | ug/L | ug/kg | ug/kg |
| Phase: | AQ | AQ | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | AQ | AQ | Solid | Solid |
| 2-Butanone | 19 B | | | | | | | | | | | | | 62 B | 50 B | 25 B |
| Methylene Chloride | | | 7 B | 8 B | 24 B | 11 B | 8 B | 21 B | 9 B | 4 B | 2 B | 12 B | | | 10 B | 5 B |
| Chloroform | | | 3 B | 3 B | | | | | 4 B | | | | | | | |
| Acetone | | | | | | | | 110 B | | | | | | 250 B | 200 B | 110 B |
| Carbon Disulfide | | | | | | | | 6 J | | | | | | | | |
| Toluene | | | | | | | | | | | | | | | 2 J | |

VBLK = Volatile Blank

COMMONWEALTH of VIRGINIA

TABLE 3 ORGANIC DATA SUMMARY
VOAs

ORIGINAL

| DRAWN BY: | REVIEWED: | DATE: 9/9/88 |
|---|---|---|

Project: Allied Chem. Co., Front Royal
Organic BNA

| Sample #: | FB-1 | S-1 | SD-1 | SD-2 | SD-3 | SD-4 | SD-5 | SD-6 | SD-7 | SD-9 | SBLK | SBLK | SBLK | SD-1 | SD-4 | SD-5 | PBLK | PBLK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| units: | ug/L | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/L | ug/kg | ug/kg | ug/kg | ug/L | ug/kg |
| Sample Description: | Field Blank | | | | | | | | | | SBLK-1 10602 | SBLK-2 10602 | SBLK-1 10620 | | | | | |
| Phase: | AQ | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid | AQ | Solid | Solid | Solid | AQ | Solid |
| Phenanthrene | | 56 J | 840 | 1800 J | 410 J | 460 J | | | | | | | | | | | | |
| Fluoranthene | | 270 J | 1400 | 4600 J | 660 J | 560 J | 4500 J | 160 J | 2000 J | 94 J | | | | | | | | |
| Pyrene | | 360 J | 2000 | 2000 J | 820 J | 530 J | 2500 J | 230 J | | 110 J | | | | | | | | |
| Benzo(a)anthracene | | 190 J | 790 | 2400 J | 390 J | 260 J | | 150 J | | | | | | | | | | |
| Chrysene | | 210 J | 990 | 1900 J | 520 J | 430 J | | 180 J | | 54 J | | | | | | | | |
| Benzo(b)fluoranthene | | 390 J | 1700 | 4000 J | 940 | 730 J | 3500 J | 330 J | 2100 J | 54 J | | | | | | | | |
| Benzo(a)pyrene | | 220 J | 890 | 2000 J | 380 J | 300 J | 4000 J | | 1300 J | | | | | | | | | |
| Indeno(1,2,3-cd)pyrene | | 100 J | 450 J | 980 J | 260 J | 140 J | | | | | | | | | | | | |
| Benzo(g,h,i)perylene | | 110 J | 500 J | | 280 J | 150 J | | | | | | | | | | | | |
| Anthracene | | | 190 J | | | 96 J | | | | | | | | | | | | |
| bis(2-ethylhexyl)phthalate | | | 1500 | | 410 J | | 3200 J | | | 170 J | | | | | | | | |
| Diethyphthalate | | | | | | | | | | | | | 1 J | | | | | |
| | | | | | | | | | | | | | | 3100 | | 4300 J | | |
| Aroclor-1254 | | | | | | | | | | | | | | | 39 J | | | |
| Gamma BHC | | | | | | | | | | | | | | | | | | |

SBLK = semivolatile Blank
PBLK = pesticide Blank

(Post) ORIGINAL

COMMONWEALTH of VIRGINIA

TABLE 4 ORGANIC DATA SUMMARY
BNAs

| DRAWN BY: | REVIEWED: | DATE: 9/8/88 |
|---|---|---|

## 7.0 EXPOSURE ASSESSMENT

### 7.1 Ground Water

No ground water samples were collected, however, the potential for ground water contamination exists because the drainage ditch, containment ponds and landfilled areas are unlined. Various compounds were detected in the water and the sediments of the ponds and drainage ditch.

### 7.2 Surface Water

Significant levels of aluminum, chromium, cobalt, copper, iron, lead, manganese, silver and 2-butanone were detected in surface water samples taken at the site. A potential threat to human health exists due to run-off from the site possibly entering the South Fork of the Shenandoah River which is used for recreation, fishing and water supply.

### 7.3 Direct Contact

The portion of the site outside the old processing area is not fenced. Therefore, there is a potential for direct contact with any contaminants found in samples taken at the site.

### 7.4 Food Chain

Since significant levels of certain compounds have been detected in various sediment and surface water samples on-site, the potential exists for these contaminants to affect the food chain. Run-off from the site may enter the South Fork of the Shenandoah River which is used for fishing.

### 7.5 Air Contact

No air contact is expected for any of the contaminants detected at the site.

8.0 TOXICOLOGY

MEMORANDUM

To: Emma Pope, Project Officer

From: Glenn Metzler, Toxicologist

Date: September 9, 1988

Subject: Toxicological Evaluation for Allied Corporation - Front Royal (VA-34)


Summary

Copper, lead, silver, zinc, and possibly vanadium were present in surface waters at concentrations that could potentially have adverse effects on aquatic life. However, since the waters sampled are unlikely to have a significant fauna, the main concern is aquatic life in the South Fork of the Shenandoah River, located one-quarter mile from the sampling area. At least some surface run-off from the site probably flows into the river. Dilution would most likely reduce metal concentrations so that minimal or no impacts would occur to aquatic life. Humans consuming fish from the South Fork of the Shenandoah River are unlikely to be affected.

Sediment samples contained numerous metals at generally low concentrations but still greater than background. Because most of the site is well vegetated, movement of metals adsorbed to particulates should be minimal. Lead and arsenic are of most concern for direct human contact at this site. Unless unusual conditions of exposure occur, adverse health effects from lead would be unlikely. Arsenic is a known human carcinogen so some concern is warranted. However, its concentration is low enough that the cancer risk under a reasonable exposure scenario for local children is quite low.

Sediment samples contained numerous polynuclear aromatic hydrocarbons (PAHs). Of the PAHs, some are possible human carcinogens and their concentration in several sediment samples is high enough to pose a slightly elevated lifetime cancer risk if contacted regularly, for example by local children playing at the site.

Polychlorinated biphenyls (PCBs) were detected in two sediment samples, one of them the sample location nearest the South Fork of the Shenandoah River. PCBs may be migrating to the river in amounts that could be resulting in elevated concentrations in aquatic organisms in the immediate vicinity of the site. Widespread effects are unlikely due to dilution.

Impacts to ground water in the area are unlikely due to the relative immobility of the contaminants found and their generally low concentrations.

Support Data

Copper was present to 92 ug/l in surface water. Copper has a chronic Ambient Water Quality Criteria of 12 ug/l (assuming 100 mg/l hardness) for the protection of freshwater aquatic life. Fish and invertebrates are similar in their sensitivity[1]. Lead was present up to 30 ug/l (estimated), approximately an order of magnitude over the freshwater chronic Ambient Water Quality Criteria of 3.2 ug/l (assuming 100 mg/l hardness)[1]. Zinc was detected at concentrations up to 568 ug/l. It has a freshwater chronic Ambient Water Quality Criteria of 110 ug/l (assuming 100 mg/l hardness)[1]. Vanadium was detected up to 40 ug/l (estimated). It was found at 30 ug/l in the background sample (SW-4). No Ambient Water Quality Criteria exists for this metal but EPA has recently developed an unpublished Estimated Advisory Concentration of 7.7 ug/l for freshwater based on a limited number of studies. Silver was detected in SW-6 at 10 ug/l (possibly biased low). It is reported that chronic toxicity to freshwater life may occur at concentrations as low as 0.12 ug/l[1].

Many of the samples that had the highest metal concentrations were from water that would eventually be pumped to the treatment plant at Avtex Fibers. In water that may not eventually be treated, only vanadium and silver were present in concentrations that could be of concern for aquatic organisms. A further consideration is the unlikely prospect that there is a significant aquatic fauna in the ponds and drainage ditches that were sampled. The population of aquatic organisms that may possibly be impacted are those of the South Fork of the Shenandoah River, into which the intermittent stream flows. Dilution would very likely reduce the metal concentrations to levels that would not be harmful to aquatic organisms. The metals of concern at this site are not likely to bioaccumulate to an extent that would be harmful if humans consumed fish from the area.

Sediment samples contained numerous metals of toxicological significance at concentrations above background. They include antimony (to 303 mg/kg, estimated), arsenic (to 43 mg/kg, estimated), cadmium (to 16 mg/kg, possibly biased low), chromium (to 479 mg/kg, possibly biased low), copper (to 311 mg/kg), lead (to 476 mg/kg), mercury (to 2.0 mg/kg, possibly biased high), nickel (to 291 mg/kg), selenium (to 48 mg/kg, estimated), silver (to 11 mg/kg, possibly biased low), vanadium (to 297 mg/kg), and zinc (to 1160 mg/kg, estimated). Highest concentrations for many of the metals were in sample SD-7. This is an area where surface drainage could be to the intermittent stream with discharge to the Shenandoah River and not to the holding pond for subsequent

treatment. This general area appeared to be well vegetated (except in the immediate area of SD-7) so movement of large quantities of metals adsorbed to sediments is not likely.

Human contact with contaminated sediments and soils is another consideration. If humans were to utilize the area on a regular basis, for example children coming to play on the property, lead and arsenic may be of concern. Arsenic is a known human carcinogen and it also has been reported to be teratogenic and fetotoxic in animals[2]. Lead can cause irreversible brain damage and also affects the peripheral nervous system. Subtle neuropsychological and electrophysiological effects in children have been shown to coincide with elevated blood lead levels[3]. Lead can also interfere with heme synthesis, reduce erythrocyte lifespan[3], and affect kidney function[4].

Located close to the site is a residential area. Since there is no fence around the area that was sampled, children may enter the site and be exposed to contaminated soil. They may contact contaminated sediments when playing in or near drainage pathways. Possible doses that children may incur were calculated assuming children come to the site three days per week for one-half of the year and ingest 100 mg of soil per day[5]. The average body weight was assumed to be 20 kg. Exposures were averaged to give a daily dose. In the case of a carcinogen such as arsenic, a lifetime daily dose is needed so a further assumption is made that exposure occured for five years out of a 70 year lifespan. Doses calculated for exposure to the maximum concentrations found in sediments were $5.1 \times 10^{-4}$ mg/(kg-day) for lead and $3.3 \times 10^{-6}$ mg/(kg-day) for arsenic. For lead the ingested dose is lower than the Reference Dose (which is the current best estimate of a safe chronic intake) of $1.4 \times 10^{-3}$ mg/(kg-day)[6]. Multiplying the dose of arsenic by a potency factor of 1.5[7] gives an upper bound estimate of the lifetime cancer risk of $4.9 \times 10^{-6}$ or 4.9 in one million, just over the $10^{-6}$ that is often used as an acceptable figure.

One sediment sample contained a trace amount of carbon disulfide (6 ug/kg, estimated). This concentration is not of toxicological concern. Bis(2-ethylhexyl)phthalate was detected in several sediment samples up to 3.2 mg/kg (estimated). This substance has been identified as a probable human carcinogen (category B) by EPA[6] but it is not highly potent. Adverse health effects from exposure to this substance are unlikely. Numerous PAHs were detected in all sediment samples. Concentrations of total PAHs ranged up to 19.7 mg/kg (estimated) in SD-2, which is just below the old outfall of the waste containment pond. Several of the PAHs are possible human carcinogens (categories B or C in EPAs classification[6]). When these are placed into a separate category, the concentrations range up to 11.3 mg/kg (estimated), this again being in SD-2. Utilizing the exposure assumptions listed above for arsenic, the daily lifetime dose (with a soil concentration of 11.3 mg/kg) is $8.9 \times 10^{-7}$ mg/(kg-day). Multiplying this by a potency factor of 11.5[6] gives an

estimated upper bound cancer risk of 10.2 X $10^{-6}$ or 10.2 in one million.

PCBs were present in two sediment samples at concentrations of 3.1 mg/kg in SD-1 (the intermittent stream leading to the South Fork of the Shenendoah River) and 4.3 mg/kg (estimated) in SD-5 (the containment pond). When water from the containment pond is sent to the treatment plant most PCBs should be removed upon sedimentation. PCBs detected in SD-1 could be migrating to the South Fork of the Shenandoah River. Their persistence and bioaccumulating potential may result in elevated concentrations in some aquatic organisms. EPA has calculated that a concentration of 0.079 ng/l in water could result in a PCB concentration in fish tissue that would pose a $10^{-6}$ lifetime cancer risk if consumed regularly[1]. This concentration could easily be exceeded in water draining from the site given the sediment concentrations. Because of the large dilution factor, overall effects from PCBs should be minimal although some local aquatic organisms may have elevated concentrations.

Gamma-BHC (lindane) was found in a single sediment sample (SD-4) at 39 ug/kg (estimated). Lindane is a possible human carcinogen (between categories B and C in EPAs classification[6]). Because of its presence in only one sample and its limited bioconcentrating potential in fish (a fish bioconcentration factor of 130 has been reported[6]) it would be unlikely to cause any adverse effects.

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# PHOTOGRAPHIC LOG

## APPENDIX A